

Patent Claims

1. Beam-shaping unit for generating a ring-shaped beam bundle with a focusing lens (2) followed by a first axicon (1) which is arranged with the focusing lens (2) on a common optical axis (9) and whose conical optical surface faces the focusing lens (2), characterized in that a second axicon (3) is arranged on the optical axis (9) in front of the focusing lens (2) with its conical optical surface remote of the focusing lens (2) and the parameters of the focusing lens (2) and of the axicons (1), (3) and their distances from one another are selected in such a way that a beam bundle coming from a radiation source (6) arranged on the optical axis (9) in front of the second axicon (3) and passing through the beam-shaping unit (4) is shaped into a ring-shaped beam bundle which is focused in a first focus point (8) and which subsequently diverges and which has a central radiationless area.

2. Arrangement for introducing radiation energy into a workpiece (14) comprising a weakly absorbent material, with a radiation source (6) and a resonator unit (5), comprising a first resonator mirror (13) and a second resonator mirror (19) between which the workpiece (14) is fixed, characterized in that a beam-shaping unit (4) according to claim 1 is arranged in front of the resonator unit (5) and the first resonator mirror (13) is located in the radiationless central area behind the first focus point (8), in that there is a collecting lens (12) which surrounds the first resonator mirror (13) and which focuses the incident beam bundle in the workpiece (14) in a second focus point (15), in that the second resonator mirror (19) is located in a radiationless central area behind the second focus point (15) and surrounded by a focusing mirror (18) which shapes the divergent beam bundle coming from the second focus point (15) into a convergent beam bundle and reflects it onto a mirror (17) that is arranged between the focusing mirror (18) and the workpiece (14) and reflects the beam bundle on to the second resonator mirror (19), in that the mirror (17) has a hole (16) that is just large enough to allow the beam bundle coming from the second focus point (15) and traveling in the direction of the focusing mirror (18) to pass through without being influenced and through which the beam bundle reflected by the second resonator mirror (19) passes without being influenced and is focused a second time inside the workpiece (14) in a second focus point (15) before subsequently striking the first resonator mirror (13) and being reflected back by the latter into the workpiece (14).

3. Arrangement according to claim 2, characterized in that the parameters of the second resonator mirror (19) and of the focusing mirror (18) are selected in such a way that, before striking the second resonator mirror (19), the beam bundle reflected by the focusing mirror (18) is focused in a third focus point (20) that is imaged in the second focus point (15) by the second resonator mirror, and in that the parameters of the first resonator mirror (13) are selected in such a way that a beam bundle coming from the second focus point (15) and impinging on the first resonator mirror (13) is focused in the third focus point (20).

4. Arrangement according to claim 2, characterized in that the parameters of the second resonator mirror (19) and of the focusing mirror (18) are selected in such a way that the beam bundle reflected by the focusing mirror (18) is focused in the second focus point selectively with or without intermediate focusing a second time after reflection at the second resonator mirror (19), a third time after reflection at the first resonator mirror (13), and a fourth time after a repeated reflection at the second resonator mirror (19), and a beam decoupling unit (22) is arranged in front between the radiation source (6) and the beam-shaping unit (4) and prevents beam components from being coupled back to the radiation source (6).

5. Arrangement according to claim 3, characterized in that the radiation source (6) emits linearly polarized light and the beam decoupling unit (22) is formed by a polarizer (23) and a quarter-wave plate (24).

6. Arrangement according to claim 2, characterized in that an additional radiation source (27) is provided for generating a starting crack and the additional beam of this additional radiation source (27) can be focused occasionally in the workpiece (14) by a lens (26) and a deflecting unit (25).